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BLASTING EXPLOSIVE COMPOSITION AND METHOD

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This invention relates to a new and improved form of explosive and particularly to a high explosive free from nitroglycerin, possessing favorable properties, and in a form convenient for use.

It has long been recognized that black powder is an excellent coal-getting explosive in so far as its blasting effect is concerned. A very desirable heaving effect is obtained with this explosive, which results in an increased amount of the desired lump coal rather than an undue shattering of the material. The disadvantages of black powder are from the safety point of view, since its explosion is accompanied by a flame of considerable duration, which tends to ignite any inflammable gases present in the coal mine.

Because of the safety hazards with black powder, this has been largely replaced in coal mines by permissible explosives, which possess a much higher degree of safety against gas and coal dust ignitions. The permissibles commonly comprise compositions high in ammonium nitrate content and containing sufficient nitroglycerin to impart a proper degree of sensitiveness to the explosive. Such compositions usually have a higher velocity of detonation than is desired, because of the presence of the nitroglycerin, and the presence of this latter ingredient is a drawback in several respects. The permissibles likewise are ordinarily of a pulverulent nature, so that spilling of some of the explosive is likely, if an attempt is made to use a portion of a cartridge.

The object of the present invention is an improved explosive of relatively low velocity adapted to the blasting of coal. A further object is an explosive of relatively low velocity in a form convenient for handling. A further object is an explosive possessing a high degree of safety in inflammable atmospheres and constituting an improvement over granular permissibles. A still further object is an explosive of convenient form adapted for blasting down coal without undue shattering. Additional objects will be disclosed as the invention is described more in detail hereinafter.

The foregoing objects are accomplished according to my invention by producing a cohesive block of explosive comprising a granulated blend of an inorganic oxidizing salt and at least one oxidizable material, these grains being surrounded by a more sensitive explosive medium capable of initiation by a commercial initiator, for example, a blasting cap, and of propagation of the explosion throughout the entire cohesive block of explosive.

Various methods may be followed in preparing cohesive blocks of explosive according to my invention. The following examples will serve as illustrations of specific procedures which will enable those skilled in the art to duplicate my product:

Example 1

The following ingredients were weighed out in the amounts designated:

	Grams
Ammonium nitrate	8500
Sodium nitrate	800
Wood pulp	600
Sulfur	100
	10,000

Five hundred grams of water was added to the above and the composition was intimately blended by causing heavy, revolving wheels to pass through and over it for a period of 80 minutes, small plows in advance of the wheels acting to throw the material into the path of said wheels. The caked material was then dried and granulated. The fines passing a 16-mesh screen were discarded and the grains held on that screen were retained. The coarse grains thus obtained had an apparent density of 1.25 and were sufficiently insensitive so that they could not be detonated with a commercial blasting cap.

The following loose explosive composition was then prepared:

	Grams
Ammonium nitrate	7500
Sodium nitrate	800
Wood pulp	800
Aluminum powder	400
TNT	500

The first three of the above ingredients were mixed under revolving wheels for a period of 30 minutes, after addition of 300 grams of water. The TNT was added and a further wheeling time given of 10 minutes, after which the aluminum was added and the complete mixture mixed under the wheel for 10 minutes more. The damp, mixed charge was passed through a 10-mesh screen and added, while still damp, to the coarse, dry grains prepared in the first step of the process, the proportion of fines to grain being approximately 2 to 1. The fine material was sensitive to the action of a blasting cap, hence served as a sensitizer for the grains.

The blend of coarse grains and fine material was tamped lightly into a die or mold and made cohesive by compressing sufficiently to allow removal from the mold without disintegration. The die or mold was provided with a tapered rod or pin extending coaxially through it and attached to the removable base of the mold. This rod or pin with withdrawn after the pellet was formed, leaving a coaxial hole in the pellet. The pellet was then dried at 120–140° F. The pellets weighed approximately 16.3 grams per linear inch (1¼" diameter), and when four pellets were

wrapped in paper to form an 8" cartridge the wrapped weight was 140 grams. The pellets were sufficiently sensitive to propagate the explosion across an air gap of 6 inches, when shot with a blasting cap introduced into the center hole. The velocity of detonation, when shot confined in tin tubes, was 1980 meters per second, or about 1800 meters when shot unconfined.

Example 2

A granular form of explosive, in which the grain size was such that the material was held on a 16-mesh screen, was prepared from the following composition:

	Per cent
Ammonium nitrate	84
Sodium nitrate	10
Wood pulp	6

The grains were prepared as in Example 1 and were insensitive to the action of a blasting cap.

The following composition was then incorporated in a mixing apparatus at 85° C. and subsequently cooled in the mixer to 45° C.:

	Per cent
Ammonium nitrate	76
Calcium cyanamide	3
TNT	20
Wood pulp	1

This blend of materials was screened through a 10-mesh sieve and mixed with the coarse, dry grains of the first step of the process, in the proportion of 3 parts of the granular to 2 parts of the sensitizing explosive. The mixture was formed, as before, into pellets having longitudinal center holes. No water was added to the mixture which was cohesive, as made, and which hardened on standing. The pellets made were 1¼" in diameter by 2" long, with a central hole of ⅜" diameter. The pellets had a weight of 20 grams per linear inch. Four pellets were enclosed end to end in a paper wrapper and had a wrapped weight of 168 grams. The pelleted explosive had a velocity of 2160 meters per second when shot in a tin tube, and propagated the explosion across a 1-inch air gap.

Example 3

A grain was prepared which would pass a 6-mesh screen but which was held on a 16-mesh screen, the composition of the grain being as follows:

	Per cent
Ammonium nitrate	80.6
Sodium nitrate	8.9
Nitrocotton	4.5
Carbonaceous combustible material	6.0

The grains were prepared in the manner described in U. S. Patent 2,171,379, and were sensitive to the action of a blasting cap.

A loose matrix composition was then prepared by incorporating the following composition in a mixing apparatus at 85° C. and cooling in the mixer to 45° C.:

	Per cent
Ammonium nitrate	76
Calcium cyanamide	3
TNT	20
Wood pulp	1

This latter mixture was screened through a 10-mesh sieve and blended with the coarse, dry grains of the first step, in the proportion of 3 parts of the grain to 2 parts of the sensitizing explosive. The mixture was formed into pellets 2" in length by 1¼" diameter, having a center hole of ⅜" diameter. The mixture was cohesive as made and hardened on standing. Four pellets were wrapped end to end in a paper wrapper to form a stick of explosive, which showed a velocity of detonation of 1350 meters per second when enclosed in paper wrapper, and propagated the explosion across a 7" air gap.

In the foregoing examples, the blend of coarse grains and fine material was formed into cylindrical pellets by pressing lightly in a press. Another satisfactory method of preparing my product comprises taking a preformed combustible receptacle, for example, a paper shell approximately 8" in length and 1¼" in diameter, and filling this shell with the lightly pressed, damp mixture. The shell and its contents are then dried together so that a cohesive block of explosive results. Desirably, a central, longitudinal hole will be formed in the cartridge, while the material is still wet. It will be apparent, therefore, that my invention covers any cohesive block of explosive, however formed, so long as it comprises the described blend of coarse grains and more sensitive surrounding explosive.

The composition of the grains of my product comprises at least one inorganic oxidizing salt and at least one oxidizable material. Various oxidizing salts are available for such use and I prefer to employ an ammonium salt, for example, ammonium perchlorate or ammonium nitrate. Ammonium nitrate is the preferred salt for use because of its known properties and its availability. Other salts, however, may be used such as sodium or potassium perchlorate, sodium nitrate, potassium nitrate, and the like. Various combustible ingredients are likewise suitable, such as wood pulp, various meals and flours, starch and plant products generally, sulfur, finely divided metals, and the like. It will be understood that more than one combustible ingredient may be used in the same composition, and more than one oxidizing agent. My preferred composition for grain, for example, includes both ammonium and sodium nitrate. More than 50% ammonium nitrate will be present ordinarily in said grain, and preferably more than 75%. The combustible ingredients will desirably be present in an amount sufficient approximately to utilize the available oxygen in the oxidizing agent in burning to carbon dioxide and water.

Any explosive composition sufficiently sensitive to be initiated by a commercial initiator and to cause propagation of the explosion throughout the entire block comes within the scope of my invention. Preferably, this sensitive composition wil be free from nitroglycerin and other liquid explosives. I find here also an ammonium nitrate composition to be suitable, preferably one containing a relatively high percentage of this salt, for example, over 70%, and at least one sensitizing agent for the ammonium nitrate, such as aluminum, trinitrotoluene, and the like.

My explosive composition has been described as consisting of relatively coarse grains of an explosive mixture in intimate contact with a more sensitive matrix explosive. While I do not wish to be limited as to the size of grains, preferably they are sufficiently large to be held on a 30-mesh screen. I find particularly desirable grains held on a 16-mesh screen. Such grains by themselves are ordinarily not sufficiently sensitive to be detonated by a #6 or #8 blasting cap.

In the preparation of cohesive blocks of explosive according to my invention, it is necessary to add water to the more sensitive explosive matrix,

in order that the molded product shall possess sufficient cohesiveness. While various amounts of water may be introduced, we find it desirable to maintain in the mixture an amount of water amounting to at least 2% of this more sensitive portion. This water is removed in the subsequent drying of the pellet or other form of cohesive block.

In the foregoing I have described the embodiment of my invention which I greatly prefer to employ, namely, the cohesive block of the compositions noted. However, it is to be understood that I do not exclude from the broad scope of my invention the particular compositions themselves before they have been molded into block formation. Even these, due to the combined effect of the ingredients and their particular physical arrangement, namely, pellets surrounded by continuous matrix, offer extensive advantages over the compositions of the prior art, especially for the blasting of coal.

My invention is particularly applicable to detonating explosives, for example, those high in ammonium nitrate content. It should be understood, however, that it is not necessarily limited to such explosives. While the invention has been described in detail in the foregoing, it will be understood that many variations may be introduced without departure from the spirit thereof. I wish to be limited only by the following patent claims.

I claim:

1. A detonating explosive comprising grains held on a 30-mesh screen and composed of an inorganic oxidizing salt and at least one oxidizable material and surrounding said grains a more sensitive explosive medium free from liquid explosive compounds and comprising a sensitized alkali nitrate composition said medium being capable of initiation by a commercial initiator the whole adhering together to form a cap sensitive cohesive block.

2. A detonating explosive comprising grains held on a 30-mesh screen composed of ammonium nitrate and at least one oxidizable material and surrounding said grains a more sensitive explosive medium free from liquid explosive compounds and comprising a sensitized ammonium nitrate composition said medium being capable of initiation by a commercial initiator the whole adhering together to form a cap sensitive cohesive block.

3. A cohesive block of detonating explosive comprising a granulated blend of an inorganic oxidizing salt and at least one oxidizable material, said grains being substantially surrounded by a more sensitive explosive medium free from liquid explosive compounds and comprising a sensitized ammonium nitrate composition said medium being capable of initiation by a commercial initiator and of propagation of the explosion throughout the entire cohesive block.

4. A cohesive block of detonating explosive comprising a granulated blend of an oxygen-supplying ammonium salt and at least one oxidizable material, said grains being substantially surrounded by a more sensitive explosive medium free from liquid explosive compounds and comprising a sensitized ammonium nitrate composition said medium being capable of initiation by a commerical initiator and of propagation of the explosion throughout the entire cohesive block.

5. The cohesive block of detonating explosive of claim 4, in which the ammonium salt is ammonium nitrate.

6. The cohesive block of detonating explosive of claim 4, in which the ammonium salt is ammonium perchlorate.

7. A cohesive block of detonating explosive of the detonating type comprising a blend of ammonium nitrate and at least one oxidizable material, said blend being in the form of grains sufficiently large to be held substantially on a 30-mesh screen, said grains being in intimate contact with a more sensitive explosive medium free from liquid explosive compounds and comprising a sensitized ammonium nitrate composition said medium being capable of initiation by a commercial blasting cap and of propagation of the explosion throughout the entire cohesive block.

8. A detonating explosive of claim 7, in which the cohesive block comprises a compressed cylindrical pellet.

9. The detonating explosive of claim 7, in which the cohesive block comprises a preformed, substantially cylindrical cartridge of combustible material substantially filled with the explosive mass compacted in situ.

10. The cohesive block of detonating explosive of claim 7, in which a substantially central perforation extends longitudinally throughout said block of explosive.

11. The method of preparing a detonating explosive which comprises forming a granulated blend of an inorganic oxidizing salt and at least one oxidizable material, intermingling said grains intimately with a more sensitive explosive medium free from liquid explosive compounds and comprising a sensitized ammonium nitrate composition said medium being capable of initiation by a commercial initiator and of propagation of the explosion throughout the mass, maintaining a water content amounting to at least 2% of the more sensitive explosive, forming said mixture into a cohesive block of explosive, and drying said cohesive block.

12. The method of preparing cohesive blocks of detonating explosive which comprises forming a granulated blend of an explosive ammonium salt and at least one oxidizable material, intermingling said grains intimately with a more sensitive explosive medium free from liquid explosive compounds and comprising a sensitized ammonium nitrate composition said medium being capable of initiation by a commercial initiator and of propagation of the explosion throughout the mass, maintaining a water content of at least 2% of the more sensitive explosive medium, forming said mixture into a cohesive block of explosive, and drying said cohesive block.

13. The method of preparing cohesive blocks of detonating explosive which comprises forming a compressed blend of ammonium nitrate and at least one oxidizable material, said blend being in the form of grains sufficiently large to be held substantially on a 30-mesh screen, intermingling said grains intimately with a more sensitive explosive medium free from liquid explosive compounds and comprising a sensitized ammonium nitrate composition said medium being capable of initiation by a commercial blasting cap and of propagation of the explosion throughout the mass, maintaining a water content of at least 2% of the more sensitive explosive medium, forming said mixture into a cohesive block of explosive, and drying said cohesive block.

14. The method of producing substantially cy-

lindrical, detonating explosive pellets, which comprises forming a blend of ammonium nitrate and at least one oxidizable material, said blend being in the form of grains sufficiently large to be held substantially on a 30-mesh screen, intermingling said grains intimately with a more sensitive explosive free from liquid explosive compounds and comprising a sensitized ammonium nitrate composition said explosive being capable of initiation by a commercial blasting cap and of propagation of the explosion throughout the mass, maintaining a water content of at least 2% of the more sensitive explosive, compressing said wet mixture into a substantially cylindrical pellet, and drying said pellet.

15. The method of producing a stick of cohesive detonating explosive, which comprises forming a blend of ammonium nitrate and at least one oxidizable material, said blend being in the form of grains sufficiently large to be held on a 30-mesh screen, intermingling said grains intimately with a more sensitive explosive free from liquid explosive compounds and comprising a sensitized ammonium nitrate composition said explosive being capable of initiation with a commercial blasting cap and of propagation of the explosion throughout the mass, maintaining a water content of at least 2% of the more sensitive explosive, introducing said wet mixture into a preformed, substantially cylindrical cartridge of combustible material, and drying said mixture in situ.

16. The method of claim 13, in which a central, longitudinal perforation is formed in said cohesive block of explosive during its formation and prior to the drying of said block.

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